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Safety and Efficacy of Bronchoscopy in Critically Ill Patients With Coronavirus Disease 2019

To the Editor:

Coronavirus disease 2019 (COVID-19) can progress to severe respiratory failure that requires intubation and mechanical ventilation, with a grim prognosis in this subset of patients.[1-4] Despite the perceived increased risk from aerosol-generating procedures, data from prior severe acute respiratory syndrome suggests no increased transmission from bronchoscopy.[5] There is a paucity of data regarding the actual risk and benefit of bronchoscopy for patients with COVID-19, which leads to uncertainty regarding recommendations.

The hypothesis of this report is that bronchoscopy with intermittent apnea is safe for both patients and health-care providers. This study reports our experience with therapeutic bronchoscopy in patients with severe COVID-19.

Methods

This is a retrospective analysis of all patients who were admitted to the New York University Langone Health (NYULH) Manhattan campus from March 13 to April 24, 2020, with COVID-19 and respiratory failure that required mechanical ventilation and who underwent bronchoscopy. COVID-19 was diagnosed by nasal pharyngeal swab for reverse transcriptase polymerase chain reaction (rtPCR) assays. Indications were concern for superimposed pneumonia, thick secretions with decreasing tidal volumes, evidence of endotracheal tube obstruction not resolved by suctioning, or significant bloody secretions. The NYULH institutional review board approved this human subjects study.

Bronchoscopy Technique

All procedures occurred in the ICU in a negative pressure room with personnel wearing full personal protection equipment (hair cover, fitted N95 mask, face-shield, gown, and gloves). In-room personnel was minimized, consisting of the bronchoscopist with the bedside nurse immediately available but outside the room. Patients were preoxygenated for 2 minutes with a F_{IO_2} of 1.0 to maximize apneic time. For patients who were not receiving sedation and/or neuromuscular blockade, periprocedural anesthesia was administered with the use of propofol and rocuronium to decrease risk of spontaneous breathing that could lead to aerosolization.

A disposable Ambu aSCope 5 23-3/5 and Ambu aView (Ambu Inc., Columbia, MD) was the bronchoscope used. After preoxygenation was complete, the ventilator was placed in standby mode, and the endotracheal or tracheostomy tube was disconnected from the ventilator. Bronchoscopy occurred in a routine manner to clear all secretions, clots, or mucus plugs. If the oxygen saturation decreased below 90%, bronchoscopy was interrupted, and the patient was reconnected to the ventilator. After an additional period of preoxygenation, bronchoscopy was then completed. BAL samples were collected at the request of the treating ICU team or in the presence of purulent secretions.

Outcomes

The primary outcomes for this study were patient and health-care provider safety, defined as freedom from periprocedural complications and COVID-19 transmission, respectively. Secondary outcomes included secondary infection with bacterial or fungal pneumonia.

Statistical Analysis

Descriptive statistics were used to summarize the data and results, which were reported as medians and interquartile ranges, for all nonparametric data.

Results

From March 13 to April 24, 2020, 412 patients with confirmed COVID-19 were admitted to the NYULH Manhattan ICU; 321 patients required intubation; 107 patients (33% of intubated patients) underwent bronchoscopy, and 241 bronchoscopies were performed during the study period (Table 1). No periprocedural complication of severe hypoxia that required bag-valve ventilation, pneumothorax, or intraprocedural arrhythmias occurred. Three patients required endotracheal tube advancement or replacement for dislodgement during the procedure.

BAL Results

Fifty-four patients (50.5%) received BAL, and 35 patients (65%) had a positive culture (Table 2). Of 23 patients with a negative tracheal culture, eight patients had a positive BAL, which indicated a 35% diagnostic yield for patients with negative tracheal aspirates. Three patients had differing cultures between the BAL and tracheal aspirate, with one culture grew *Pseudomonas* and *Klebsiella* in the tracheal aspirate with *Enterococcus* in the BAL, and the cultures for the other two patients grew an extra pathogen (*Escherichia coli* or *Serratia*) in the BAL.

TABLE 1] Characteristics and Outcomes of Patients With Bronchoscopy

Variable	Patients Who Underwent Bronchoscopy (N = 107)
Sex, No. (%)	
Male	87 (81.3)
Female	20 (18.7)
Age, median (IQR), y	62 (47-69)
Total bronchoscopies, No.	241
Bronchoscopies per patient, median (IQR), No.	1 (1-3)
Bronchoscopies per provider, median (IQR), No.	42 (6-67)
Follow up, median (IQR), d	17 (11.5-24)
Tracheostomy during hospital stay, No. (%)	78 (72.9)
Extracorporeal membrane oxygenation during hospital stay, No. (%)	25 (23.4)
Patient disposition, No. (%)	
Discharged from the hospital	22 (20.6)
Remains inpatient	56 (52.3)
Death	29 (27.1)
Ventilator requirement, No. (%)	
Off the ventilator	35 (32.7)
Pressure support ventilation	14 (13.1)
Full mechanical ventilation support	29 (27.1)
Not applicable: death	29 (27.1)
Tracheal aspirate, No. (%)	
Patients with tracheal aspirate	92 (86)
Positive cultures	41 (38.3)
BAL, No. (%)	
Patients with BAL	54 (50.5)
Positive culture	35 (32.7)
Patient with positive culture, No. (%)	58 (54.2)

IQR = interquartile range.

Health-Care Provider Outcomes

The bronchoscopy team included six cardiothoracic surgeons and four cardiothoracic surgery residents. One cardiothoracic surgery resident was COVID-19 positive by rtPCR prior to performing any bronchoscopies. The remaining nine team members were negative for COVID-19 via nasal pharyngeal swab for rtPCR assay, with at least one negative test performed 2 weeks after the last bronchoscopy.

TABLE 2] BAL and Tracheal Aspirate Culture Results

Variable	BAL (n = 54)	Tracheal Aspirate (n = 92)
Positive culture, No. (%)	35 (65)	41 (45)
Beta hemolytic *Streptococcus*	1	0
Burkholderia	2	1
Candida	11	1
Citrobacter	1	0
Escherichia coli	3	4
Enterobacter	2	1
Enterococcus	2	0
Klebsiella	8	15
Methicillin-resistant *Staphylococcus aureus*	2	4
Methicillin-sensitive *S aureus*	3	12
Pseudomonas	1	3
Serratia	3	4
S epidermidis	4	0
Stenotrophomonas	3	4
Cultures with ≥2 infections, No. (%)	10	8
Negative culture, No. (%)	19 (35)	51 (55)

Discussion

This study demonstrates the safety and feasibility of performing bronchoscopy with intermittent apnea for patients with severe COVID-19. We noted a 33% rate of bronchoscopy in intubated patients, which is unusually high compared with non-COVID-19 ARDS. This increased need may be secondary to thick distal secretions that are associated with COVID-19 or bloody secretions due to the anticoagulation, given the reported increased thrombotic risk. Because of concern regarding the safety of these procedures and possible high risk of transmission of COVID-19, many providers were reluctant to perform bronchoscopy. A bronchoscopy technique designed to decrease the risk of aerosolization of severe acute respiratory syndrome coronavirus 2 was adopted. The protocol for neuromuscular blockade to decrease coughing and the performance of bronchoscopy under apnea was designed to minimize health-care provider exposure to COVID-19. Although this protocol differs from common practice, the procedure was tolerated well by patients. No health-care provider who was involved in the bronchoscopies became positive for COVID-19.

This series demonstrates a high prevalence of secondary infection with bacterial or fungal pneumonia. This rate of superinfection is important, because under diagnosis of a second pneumonia may play a key role in the excessive mortality rate for intubated patients. BAL cultures had a higher positive culture rate (65%) compared with tracheal aspirate (45%). More interesting is the high rate of positive BAL with a negative tracheal aspirate culture, which correlates to a 16% false-negative rate of tracheal aspirate cultures. Nearly one-third of BAL specimens that were collected demonstrated a secondary pneumonia in patients with no or negative tracheal aspirate cultures. An additional 6% of BALs grew a different or second organism. These data directly contradict the belief that tracheal aspirate is sufficient for the diagnosis of superimposed pneumonias for patients with COVID-19.

Strengths of this report include that it demonstrates the safety of bronchoscopy to the health-care provider, it is the largest reported series of bronchoscopies in patients with severe COVID-19, and it describes a high rate of superinfection. Additionally, the yield of positive BAL in patients with negative tracheal aspirates has not been described previously for COVID-19 patients. Limitations to this study are that it is a retrospective review and a descriptive paper.

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